

Water Withdrawal Estimation

This document details a number of suggested methods for estimating water use. They all involve knowing the energy consumption of the well, possibly in conjunction with discharge information (such as pipe or channel flow in gallons per minute), or only information concerning the energy usage if discharge information is unavailable. These methods include estimating pumpage based on:

- 1) pipe flow and discharge information (using electrical / natural gas energy records)
 - 2) open channel flow and discharge information (using electrical / natural gas energy records)
 - 3) calculating pumpage based on using hour meters
 - 4) estimating pumpage based on only electrical or natural gas energy records
- Pipe Flow & Discharge Information

Calculate Using Electrical Energy Records

This method works when the electric meter does not serve uses other than measuring power consumption by the well. Calculating water pumpage using this method involves taking two or more discharge measurements during the year (preferably during spring and late summer) in conjunction with some electric meter-specific information.

Kr – Multiplier factor from your power bill. For some pump motors, which are 200 amps or less, the electric meter may be “self-contained” and the Kr should be considered as 1 for purposes of calculating Factor A.

Kh – Constant associated with the disk of your electric meter, it is located on the faceplate of the electric meter.

Average Discharge (gallons / minute) – Based on two or more measurements that should be taken during the spring and late summer (if possible), this figure is best measured following at least 24 hours of pump operation.

Number of Seconds for 10 Revolutions – The number of seconds it takes to turn the disk of your electric meter 10 revolutions, this figure should be noted in conjunction with each discharge measurement in order to obtain an “Average Number of Seconds for 10 Revolutions” that corresponds to the “Average Discharge”.

Factor A – $Kr \times Kh$

Factor B – Average Discharge (gallons / minute)

Factor C – Average Number of Seconds for 10 Revolutions

Divider – $19,550 \times \frac{\text{Factor A} \times 10}{\text{Factor B} \times \text{Factor C}}$

Water Withdrawal = $\frac{\text{Annual Electric Consumption (kw/hr)}}{\text{Divider}}$

Note: For those using newer digital power meters, please contact your power company to obtain some of the above information. These meters utilize light pulses rather than a disk, and you will not be able to calculate the “Number of Seconds for 10 Revolutions.”

Calculate Using Natural Gas Energy Records

This method works when the gas meter does not serve uses other than measuring power consumption by the well. Calculating water pumpage using this method involves taking two or more discharge measurements during the year (preferably during spring and late summer) in conjunction with some meter-specific information.

Average Discharge (gallons / minute) – Based on two or more measurements that should be taken during the spring and late summer (if possible), this figure is best measured following at least 24 hours of pump operation.

Therm – Unit of measure for natural gas equal to about 1,000 ft³.

Factor F – Factor F shown on gas bill

Factor B – Average Discharge (gallons / minute)

Factor C – Average Cubic Feet / Sec from the gas meter

Divider – $19,550 \times \frac{\text{Factor F} \times \text{Factor C}}{\text{Factor B}}$

Water Withdrawal = $\frac{\text{Annual Gas Consumption (in therms)}}{\text{Divider}}$

Open Channel Flow & Discharge Information

Calculate Using Electrical Energy Records

This method works when the electric meter does not serve uses other than measuring power consumption by the well. Calculating water pumpage using this method involves taking two or more discharge measurements during the year (preferably during spring and late summer) in conjunction with some electric meter-specific information.

Kr – Multiplier factor from your power bill. For some pump motors, which are 200 amps or less, the electric meter may be “self-contained” and the Kr should be considered as 1 for purposes of calculating Factor A.

Kh – Constant associated with the disk of your electric meter, it is located on the faceplate of the electric meter.

Average Discharge (gallons / minute) – Based on two or more measurements that should be taken during the spring and late summer (if possible), this figure is best measured following at least 24 hours of pump operation.

Number of Seconds for 10 Revolutions – The number of seconds it takes to turn the disk of your electric meter 10 revolutions, this figure should be noted in conjunction with each discharge measurement in order to obtain an “Average

Number of Seconds for 10 Revolutions” that corresponds to the “Average Discharge”.

Factor A – Kr x Kh

Factor B – Average Discharge (gallons / minute)

Factor C – Average Number of Seconds for 10 Revolutions

Divider – $19,550 \times \frac{\text{Factor A} \times 10}{\text{Factor B} \times \text{Factor C}}$

Water Withdrawal = $\frac{\text{Annual Electric Consumption (kw/hr)}}{\text{Divider}}$

Note: For those using newer digital power meters, please contact your power company to obtain some of the above information. These meters utilize light pulses rather than a disk, and you will not be able to calculate the “Number of Seconds for 10 Revolutions.”

Calculate Using Natural Gas Energy Records

As with the other estimating calculations detailed here, this method works when the gas meter does not serve uses other than measuring power consumption by the well. Calculating water pumpage using this method involves taking two or more discharge measurements during the year (preferably during spring and late summer) in conjunction with some meter-specific information.

Average Discharge (gallons / minute) – Based on two or more measurements that should be taken during the spring and late summer (if possible), this figure is best measured following at least 24 hours of pump operation.

Therm – Unit of measure for natural gas equal to about 1,000 ft³.

Factor F – Factor F shown on gas bill

Factor B – Average Discharge (gallons / minute)

Factor C – Average Cubic Feet / Sec from the gas meter

Divider – $19,550 \times \frac{\text{Factor F} \times \text{Factor C}}{\text{Factor B}}$

Water Withdrawal = $\frac{\text{Annual Gas Consumption (in therms)}}{\text{Divider}}$

Hour Meters

This method of estimation, unlike the others detailed above, works regardless of whether or not the energy meter serves uses other than measuring power consumption by the well. Calculating water pumpage using this method involves taking two readings and measurements during the year, specifically on January 1 and December 31.

Acre-foot (AF) – Unit of water measure equal to 325,851 gallons.

Average Discharge (gallons / minute) – Based on January 1 and December 31 measurements, this figure is best measured following at least 24 hours of pump operation.

Factor A – The result of subtracting the beginning (January 1) hour reading from the ending (December 31) hour reading.

Factor B – Average Discharge (gallons / minute) from discharges measured in conjunction with each meter reading.

$$\frac{\text{Factor A} \times \text{Factor B} \times 60}{325,851 \text{ gallons}} = \text{Groundwater Withdrawal AF/yr}$$

Energy Records Only

The two following calculations can be used to estimate water withdrawals based on records of electric or natural gas use by the well. The formulae assume that the well pump(s) are connected to a dedicated energy meter that reflects energy usage only for the well pump(s). In addition to energy usage, the calculations rely on knowing the depth of the well pump. Note that this will probably be less than the overall depth of the well. If you are unsure of this depth, you may contact your pump service company, or estimate based on knowledge of local water tables.

Calculate Using Only Electrical Energy Records

Electric Well Pump

Lift Depth – Depth in feet from which well pump is pumping water.

Acre-foot (AF) – Unit of water measure equal to 325,851 gallons.

1.024 – kw/hrs needed to lift one AF of water one foot at 100 % efficiency.

.54 – Overall efficiency of electric well pump, expressed as a decimal.

$$\frac{1.024 \times \text{lift depth}}{.54} = \text{Kw hours of electricity needed to lift one acre-foot of water}$$

Example using a well with the pump set at 400 feet:

Uses 211,300 kw/hr of electricity, as shown through electric meter / billing records

$$\frac{1.024 \times 400}{.54} = 758.52 \text{ kw/hr of electricity used to pump 1 AF of water}$$

$$\frac{211,300 \text{ kw/hr}}{758.52 \text{ kw/hr/AF}} = 278.57 \text{ AF of water pumped}$$

Calculate Using Only Natural Gas Energy Records

Natural Gas Well Pump

Lift Depth – Depth in feet from which well pump is pumping water.

Acre-foot (AF) – Unit of water measure equal to 325,851 gallons.

MCF – Million Cubic Feet (ft³).

Therm – Unit of measure for natural gas equal to about 1,000 ft³.

.00318 – MCF of gas needed to lift one AF of water one foot at 100 % efficiency.

10.68 – Therms / 1,000 ft³ of gas.

.154 – Overall efficiency of natural gas pump, expressed as a decimal.

$$\frac{.00318 \text{ MCF} \times 10.68 \times \text{lift depth}}{\text{AF}} \times .154 = \text{Therms of natural gas needed to pump 1 AF of water from a known depth}$$

Example using a well with the pump set at 400 feet:

Uses 24,572.66 therms of natural gas, as shown through meter / billing records

$$\frac{.00318 \text{ MCF} \times 10.68 \times 400}{\text{of water}} \times .154 = 88.21 \text{ therms of natural gas used to pump 1 AF}$$

$$\frac{24,572.66 \text{ therms}}{88.21 \text{ therms / AF}} = 278.57 \text{ AF of water pumped}$$